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INFLUENCES ON LOCAL ADOPTION OF PLANNING MEASURES FOR EARTHQUAKE HAZARD MITIGATION*

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This article assesses the extent to which various planning measures are used by communities for mitigating earthquake hazards. A secondary aim is to examine how planning process activities and community context characteristics influence local adoption of planning measures for mitigation. A number of conclusions based on data from a national survey of communities at risk to earthquakes were derived. Communities use a wide variety of planning measures for earthquake mitigation, but the frequency of adoption of such measures was greater in California

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than in other states. Planning process activities had a more important influence on local adoption than context characteristics. This conclusion implies that local efforts to advance local earthquake mitigation programs have a substantial potential for success.

During the past decade there has been a greater emphasis in United States seismic hazards policy on mitigation. With passage of the National Earthquake Hazards Reduction Act of 1977 much funding has been directed toward research on assessment of vulnerability of populations, design of buildings to withstand earthquake forces, and delineation of earthquake hazard areas. An extensive literature exists on the potential benefits of such technical solutions (cf. Hanks 1985 and Hopper et al. 1983).

Less work has been done on understanding why use of technical solutions have not been common (Drabek 1986; Scholl 1986). The limited work that has been conducted are case studies of local experiences in western states, predominantly California (Alesch and Petak 1986; Blair and Spangle 1979; Mader 1980; Olson and Nilson 1982; Selkregg and Pruess 1984; Wyner and Mann 1986). A few studies have also examined earthquake mitigation programs in the midwest and eastern states (Atkisson and Petak 1981; Drabek et al. 1983; Lambright 1984; Mushkatel and Nigg 1987a, 1987b). The technical side of earthquake mitigation, therefore, appears more advanced than the institutional capacity of governments to use technical solutions, and to effectively anticipate and respond to earthquake hazards.

This paper examines local government planning efforts aimed at earthquake hazard mitigation. Utilizing data from a national survey, we focus on how planning process activities and community context characteristics influence local adoption of planning measures; e.g., land use regulations and development controls. More specifically, we seek to address the following three questions: first, to what extent have various planning measures been adopted for earthquake hazard mitigation? Second, what is the relative importance of process activities compared to context characteristics? Third, to what degree do factors that influence adoption differ between communities in California, and those in other states?

RELATION TO PREVIOUS RESEARCH IN PLANNING

The intent of planning is to focus upon common dilemmas of effectively anticipating and responding to uncertain future events. These events can either be slow developing (e.g., ground water contamination, drought, and decay of public infrastructure), or of rapid onset (e.g., floods, earthquakes, and mass transit disruptions). The term "planning" as discussed here refers to a process or series of collective actions undertaken to produce collective "adjustments" or public programs, services, or policies that account for the threat of a hazardous event (White and Haas 1975, p. 57). In the earthquake hazard mitigation field, for example, planning might result in adoption of measures that limit development in hazardous areas or enhance the structural integrity of buildings. Such planning typically occurs in decision-making environments where problems tend to be poorly defined, information on the consequences of collective actions is imperfect, and there are wide variations in goals, values and preferences among affected groups (cf. Alesch and Petak 1986; Wyner and Mann 1986).

Bryson (1983) contends that to understand any planning effort in these environments, the process can be conceptualized as three categories of elements: community context; process activities; and outcomes or responses. **Community context** refers to the physical, socioeconomic, legal and political characteristics of communities. **Process activities** consist of activities planners and other decision makers use to advance planning programs. The combination of context and process activities lead to various **community responses.** Such responses include adoption of planning measure such as reconstruction plans, fault setback controls and building regulations.

Previous research on the representation and testing of planning processes in the natural hazards field has followed one of two approaches. The first focuses on specific process activities to be completed with each phase of a general problem-solving model. These phases generally include: 1) initiation of agreement concerning the presence of a problem; 2) search for possible solutions; 3) adoption of a solution; 4) implementation of a solution; and 5) evaluation of effectiveness of the solution (Slovic et al. 1974).

Several studies have used this approach in examining state (Drabek et al. 1983; Lambright 1984) and local (Alesch and Petak 1986; Ender et al. 1988) efforts directed toward adoption and implementation of seismic mitigation measures. Examples of activities in phase one include presentation of expert endorsements and initiation of public awareness campaigns, while phase two activities include conducting an analysis of existing data and contracting consultants to undertake in-depth solution search, and so forth. Similarly, Olson and Nilson (1982) assess seismic safety policy in three Southern California communities. This study highlighted the need for using different political strategies in different phases of the process. In the initiation phase, for instance, coalition building efforts should focus less on government staff and more on egotechnical and engineering specialists. As the process advances to the adoption and implementation phases, such efforts would shift to political and bureaucratic leaders. The assumption behind this first approach is that use of different activities that are contingent upon different phases, as well as community contexts will produce desired results.

The second approach applies a group of generic activities either with one particular phase or across some combination of phases of a problem-solving sequence. In a study of community disaster preparedness planning, Kartez and Lindell (1987) use this approach in examining the influence of planning process activities (updating emergency plans and standard operating procedures, holding emergency exercises and joint critiques, etc.) on adoption of planning practices (establishing emergency equipment contracts, media centers, and telephone hotlines, etc.). This approach has also been used in explaining community response to earthquake hazards (Wyner and Mann 1986), coastal storms (Godschalk et al. 1989) and flooding (Burby and French 1980, 1981, 1985; Hansen and Hirsch 1983; Hutton and Mileti 1979). These studies assess, for example, the effect of various state government intervention actions, roles of key government personnel and modes of intergovernmental coordination on different phases of the problem-solving sequence.

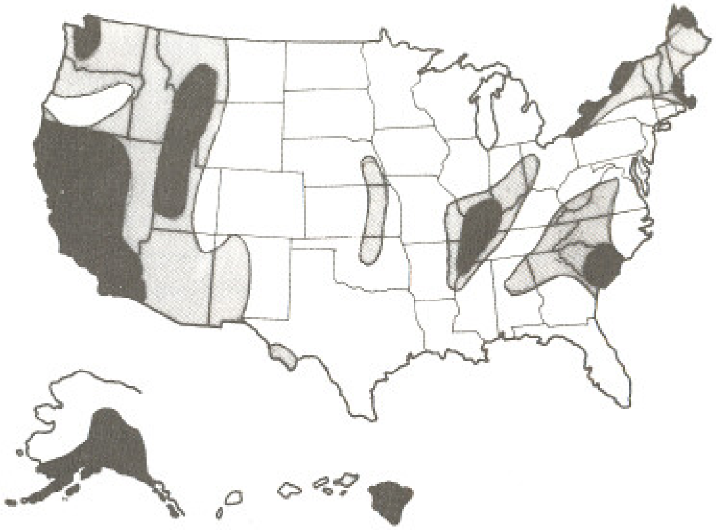
This study uses this last approach to the representation of planning processes. We focus on the adoption stage of the earthquake mitigation planning process and further distinguish three types of process activities: interorganizational relations, program operation, and program support. In particular, the effect of these activities on local response will be addressed by examining variations between communities in California and all other states. While communities throughout the nation occupy different points in the program evolution process, development of programs in California is far ahead of the rest of the nation (Scholl 1986). Thus, California communities are analyzed separately as they represent a different theoretical level of involvement in mitigation. That is, they have the most experience in applying land use and development practices in earthquake mitigation.

DATA AND METHODS

Data for the study were obtained from a national survey of communities in 22 states. These states fall within seismic zones three and four (see Figure 1) which are high seismic risk areas. A Modified Mercalli Intensity of VIII (MMI VIII) or greater is likely to occur in both zones. An intensity of MMI VIII causes major damage to the built environment. Seismic zones three and four are distinguished because zone four areas are determined to contain certain major fault systems. Zone three areas have no such fault systems. Communities in areas of lower risk (MMI VII and below) were not included in the survey. To be certain that communities were capable of establishing at least a minimal program, communities with permanent populations of less than 10,000 (as determined by the 1980 U.S. Census) were excluded, since many of them lack the resources to initiate a minimal planning effort.

A random sample of communities in California was used. The sample size of 104 communities of the 256 communites in the state was determined using a procedure developed by McMamara (1978). Because of the small number of communities in each of the remaining 21 states, all 156 communities were surveyed. Data from communities in the 22 states were obtained using a mail survey administered during the fall of 1986. The response rate for California was 82.5 percent, 78.2 percent for the other states, and 79.9 percent for the total sample. Mail survey data was supplemented with information from the U.S. Geological Survey and the U.S. Census.

As mentioned, local program development is more advanced in California than in other states. Thus, separate analyses of both groups of survey communities allows us to more carefully examine factors as-



LEGEND

Zones 0 and 1: No damage and minor damage, respectively corresponds to intensity VI and lower on the M.M. Scale.*

Zone 2: Moderate damage, corresponds to intensity VII of the M.M. Scale.

Zones 3 and 4: Severe damage, corresponds to intensity VIII and higher of the M.M. Scale.

*Modified Mercalli Intensity Scale of 1931.

FIGURE 1: Seismic Zone Map of the U.S.--Uniform Building Code
Source: Algermissen 1969

sociated with local response to the seismic threat than examination of pooled data of communities in all states.

A series of regression analyses were used to examine survey data. The dependent variable is measured as the number of earthquake mitigation measures used by the community.[1] The independent variables in the regression analyses were grouped into the four categories of factors that influence community response as discussed previously. Measures of both dependent and independent variables are discussed in detail in Appendix Table A-1.

Due to a large number of independent variables, however, a data reduction strategy was necessary. This involved two steps. The first step was to enter independent variables into four regression equations for each of the two survey groups of communities. Four equations were required as there were too many variables for a single regression equation. Each equation contained all of the variables of each of the four categories of independent variables (see Table 1). That is, all variables describing community context were entered into one equation, all variables describing program support were entered into another, and so on.

Table 1
Interorganizational Relations, Program Support Operations and Community Context Factors Related to Local Adoption Planning Measures

Categories of Factors	Standardized Beta Weights (Unstandardized)	
	California	All Other States
1. **Interorganizational Relations**		
Extent of contact with organizations	.34 (.38)***	.16 (.11)
Responsiveness of other organizations to local program needs	.23 (.25)*	.37 (.35)***
R^2 for Equation 1	.258	.248
F-ratio for Equation 1	13.706***	19.292***

More Table 1

Table 1 continued

Categories of Factors	Standardized Beta Weights (Unstandardized) California	All Other States
2. Program Support		
Staff hours	-.10 (-.32)	.23 (.72)**
Planning budget	.26 (1.16)	.10 (.38)
Budget change	.10 (.48)	.10 (.24)
Lack of higher level financial support	-.11 (-.21)	-.21 (-.28)
Inadequate expertise	.10 (.20)	.02 (.02)
Adequacy of maps	.11 (.22)	.24 (.31)**
R^2 for Equation 2	.087	.160
F-ratio for Equation 2	1.110	2.830**
3. Program Operations		
Presence of an advocate	-.08 (.44)	.29 (.97)***
Integration of seismic program	.01 (.06)	.20 (1.04)**
Linkage of seismic issues to other local issues	.38 (.80)***	.25 (.37)**
Media campaign	.09 (.55)	-.07 (-.22)
R^2 for Equation 3	.157	.263
F-ratio for Equation 3	3.349**	9.827***
4. Community Context		
Home value	-.06 (.00)	.02 (.00)
Population size	-.09 (.00)	-.04 (.00)
Conservative attitude	.17 (.39)	-.15 (-.22)
Legal restraint	.06 (.13)	-.07 (-.11)
Lack of public interest	-.06 (-.13)	-.13 (-.20)
Opposition by real estate	-.03 (-.06)	.23 (.32)
Lack of support by local elected officials	.12 (.21)	.16 (.22)
Past experience	-.09 (-.12)	.19 (.20)*
Perceived risk	.08 (.13)	-.14 (-.24)
Number of hazards	.34 (.44)***	.25 (.22)**
R^2 for Equation 4	.183	.202
F-ratio for Equation 4	1.496	2.024**

* $p < .1$
** $p < .05$
*** $p < .01$

The second step of the analysis involved entering all variables that meaningfully contributed to explaining variations in community response into a regression equation. Those variables were included whose t-values were statistically significant at the .1 level. This procedure controls across categories for the influence of all factors with moderately strong relationships to community response. Regression coefficients were standardized to allow variables within each survey group to be compared based on the relative magnitude of influence on community adoption of planning measures. Unstandardized coefficients allow variables between each survey group to be compared (see Pedhazur 1982, Pp. 247-249).

STATUS OF LOCAL EARTHQUAKE HAZARD MITIGATION

The status of local earthquake mitigation programs was assessed based on the frequency of use of each of 21 mitigation measures (see Table 2). These measure include **development regulations** (zoning, subdivision, and fault setback ordinances) to control type, location and density of development in hazardous areas; **building standards** designed to strengthen structures to withstand earthquake forces; **planning** to produce community mitigation policies; **land and property acquisition** in hazardous areas to remove existing development or prevent future urbanization; **capital facilities policies** to direct new development away from hazardous areas (or at least not to induce new development in hazardous areas); **taxation and fiscal policies** to maintain low density uses in hazardous areas; and **information dissemination** to inform the public and those involved in real estate transactions about hazards.

Five measures listed on Table 2, including building codes, zoning and subdivision ordinances, comprehensive plans and capital improvements programs, are typically enacted for nonhazard reasons, but to some extent can be used for earthquake mitigation. With the exception of capital improvements programs, a majority of communities in both California and all other states have adopted each of these measures.

In California, of the 16 measures that specifically address earthquake hazards, only two -- earthquake component of comprehensive plans and seismic resistant building standards -- were used by a majority of communities.[2] Slightly more than one in three communities used retrofit of existing buildings and public information programs. Location of critical facilities under critical and public facilities policies were used by about one in four California communities, and fault setback ordinances under development regulations were used by about one in five communities. All five land and property acquisition measures, and both taxation and fiscal policy measures were used by a much smaller percentage of California communities.

Table 2
Adoption of Planning Measures For Earthquake Hazard Mitigation

Measures	Communities in California	Communities in All Other States
Development Regulations		
Zoning ordinance	56%	66%
Subdivision ordinance	52	59
Fault setback ordinance	21	8
Building Standards		
Building code	98	82
Special seismic resistance building standards	69	9
Retrofit existing buildings	35	6
Planning		
Comprehensive or land use plan	94	60
Earthquake component of comprehensive plan	73	11
Recovery/reconstruction plan	12	7
Land and Property Acquisition		
Transfer of development potential from hazardous to non-hazardous sites	15	4
Acquisition of undeveloped lands	2	3
Acquisition of development rights	5	2
Building relocation	2	1
Acquisition of damaged buildings	0	1

More Table 2

Table 2 Continued

Measures	Communities in California	Communities in All Other States
Critical and Public Facilities Policies		
Capital improvements programs	27	33
Location of critical facilities (hospitals, schools) to reduce risk	26	9
Location of capital facilities (street, water to discourage development in hazardous areas	15	10
Taxation and Fiscal Policies		
Impact tax to cover additional public costs of building in hazardous area	0	2
Reduced or below market taxation for open space or non-intensive uses in hazardous areas	0	5
Information Dissemination		
Public information program	37	13
Hazard disclosure requirements	17	6

Source: List of planning measures adapted from Godschalk et al. (1989, Ch. 7).

As expected, compared to California communities the percentage of communities in all other states using measures specifically designed for earthquake mitigation was smaller. For example, the three most frequently adopted measures -- public information programs, earthquake component of comprehensive plans and location of capital facilities -- were only used by about one in ten communities.

The findings on California's more extensive experience call for a few words of caution. While earthquake mitigation in California is substantially higher than the rest of the nation, it is considerably lower than mitigation activity for other types of hazards (cf. Burby and French 1985; Godschalk et al. 1989). For example, comparison of data on Table 2 with results of a national survey of coastal communities by Godschalk and his colleagues reveals that frequency of use of planning measures for hurricane mitigation was much more extensive than use of such measures for earthquakes in California.

FACTORS RELATED TO ADOPTION OF PLANNING MEASURES

The independent variables performed well in explaining variations in community adoption of planning measures (Table 3).[3] The regression equations predicting the number of planning mitigation measures adopted for both survey groups of communities were statistically significant as indicated by the F-values. Furthermore, the equations explained 31.2 percent of the variance in response behavior for California and 40.7 percent for all other states, which is quite good for this type of research. In contrast, Godschalk et al. (1989), for example, were only able to explain 21.3 percent of the variation in adoption of planning measures for hurricane mitigation in their national study.

Table 3
Factors Related To Local Adoption Of Planning Measures For Earthquake Mitigation

Categories of Factors	Standardized Beta Weights (Unstandardized) California	All Other States
Interorganizational Relations		
Extent of contact with organizations	.06 (.13)	.-- --
Responsiveness of other organizations to local program needs	.20 (.22)*	.38 (.34)***
Program Support		
Staff hours allocated seismic safety	.-- --	.12 (.18)
Adequacy of maps that delineate seismic hazards	.-- --	.06 (.07)
Program Operations		
Presence of an advocate	.-- --	.20 (.68)**
Integration of seismic program formulation activities with conventional comprehensive planning activities	.-- --	.29 (.84)***
Linkage of seismic issues to other local issues	.29 (.32)**	.18 (.94)**

More Table 3

Table 3 Continued

Categories of Factors	Standardized Beta Weights (Unstandardized) California	All Other States
Community Context		
Past experience	.-- --	.07 (.07)
Number of seismic related hazards	.21 (.27)**	.22 (.19)**
R^2 for Equation	.312	.407
F-ratio	8.735***	7.376***

* p < .1
** p < .05
*** p < .01

Interorganizational Relations

This group of factors focuses on the relationship between local planning programs and their political environment. Local planning programs are embedded in a larger political context and, therefore, must acquire political support for earthquake mitigation to be effective. Two factors are examined here.

The first is the frequency of contact between local program staff, and federal, state, and local organizations. Previous research indicates that interorganizational contact in a policymaking arena has a positive impact on community response to earthquake hazards (Wyner and Mann 1986). Opportunities for sharing information, and generating common outlooks and ways of thinking among participating organizations are enhanced as interorganizational contact increases. Participants become more aware of the interests and activities of others. Issues of local concern have a greater chance of being communicated to state and federal agencies. Technical and financial support from higher levels of government are more likely to fit specific needs of local programs. Our findings, however, do not uphold previous research. As indicated on Table 1, the extent of contact has an insignificant impact on local adoption of earthquake mitigation measures.

In contrast, the second factor, perceived responsiveness of federal, state and other local organizations to local program mitigation efforts, has a much more important impact on local response for both groups. This finding supports the Drabek et al. (1983) interpretation of interorganizational relations. That is, the frequency of contact suggests nothing about the content or perceived usefulness of such contact. For example, highly technical reports from higher levels of government may not foster local understanding of the nature of seismic risk.

Program Support

These factors refer to the extent of resources available for initiation and adoption of local earthquake mitigation programs. The forms of support discussed here include amount of planning staff time devoted to earthquake hazards and adequacy of maps that delineate earthquake hazards.

Staff time was expected to have a positive impact on local response. More time allows staff to devote greater attention to activities required for initiating and adopting seismic mitigation measures. The results for staff time, however, were not consistent with our expectations. Table 3 indicates that this factor has an insignificant effect in local adoption in communities from both California and other states.[4]

Program Operation

This group of factors refers to the procedural aspects of a planning program. Factors discussed here include the role of seismic safety advocates, and linkage of earthquake hazards to comprehensive planning programs and other local concerns.

The presence of advocates that promote earthquake hazard mitigation was hypothesized to have a positive effect on local adoption of mitigation measures. Advocates are those participants in the planning process willing to invest their resources -- time, energy and money -- to assure that a particular issue is raised on governmental agendas. Advocates have been found to be a strong moving force in hazards mitigation planning (Alesch and Petak 1986).

The results only partially supported the hypothesized importance of advocates. While this factor significantly influenced adoption of mitigation measures in communities outside California, it had little impact on communities in California. This difference is probably attributed to the fact that advocates have been found to play a strong role in localities where mitigation planning is a new and an emergent function (Lambright 1984). In contrast, in communities with more established programs, adoption of additional mitigation measures is more likely to occur with relatively less change in the status-quo. Consequently, compared to communities in other states, advocates in California may not be as important as the time our survey data was collected.

A key determinate of adoption of mitigation measures is when natural hazard issues that are traditionally of low political salience, are integrated with well established and politically acceptable ways of doing things. Berke (forthcoming), for example, found that integration of hurricane evacuation issues with a well-established urban development permit-review process, led to state and local enactment of an emergency shelter program. We hypothesize, therefore, that seismic issues can progress on local agendas through integration with conventional local planning activities. Our expectation of the positive impact of such integration to local adoption was only partially supported. This factor had no significant influence in California, but played an important role in communities of other states.

This difference may be due to California's requirement that communities develop and incorporate several mitigation measures into their comprehensive plans. Since integration is required, it may deemphasize local involvement and commitment. Previous research supports this interpretation. Wyner and Mann (1986) found that while California communities integrated seismic safety elements into their comprehensive plans, these elements were rated by local officials as low in importance in fostering additional community mitigation action. Other states, however, have no such requirements. If communities in these states integrated seismic program activities with conventional comprehensive planning activities, it probably originated at the local level. Planners, therefore, were likely to perceive such efforts as important.

We hypothesized that linkage of seismic safety issues to one or a combination of other local issues, such as environmental protection, economic development or recreation, would have a positive impact on adoption of mitigation measures. As one of a group of issues, or in some cases as a tool to be used for very different goals, e.g., stopping new development for purposes of environmental protection or encouraging renovation and reinforcement of buildings in declining downtowns, the earthquake issue can be raised on political agendas (Drabek et al. 1983). Table 3 show that our hypothesis is supported for communities in both California and other states.

Community Context

As discussed, context refers to the characteristics of communities in earthquake prone areas. Of the original 10 context factors considered in the survey data (see Table 1) only the number of earthquake related hazards was found to be significant. This finding was consistent with our expectations. That is, the greater the number of hazards present in the community, the more likely a greater variety of mitigation measures will be required. Communities that are exposed to only ground shaking, for example, might require a seismic building code ordinance, but communities exposed to ground shaking, landslides, and faults might require both building code and land use controls.[5]

As indicated in Table 3, disaster experience reached the second regression equation, but was not significant. This finding does not uphold previous research which generally maintains that disaster experience has a strong positive impact on adoption of mitigation measures (cf. Godschalk et al. 1989; Drabek et al. 1983; Wyner and Mann 1986). This suggests that while a disastrous event may provide a window of opportunity for adoption of mitigation measures, the windows can close quickly during the immediate disaster aftermath with no ensuing follow-up activities. Some research findings (Alesch and Petak 1986; Burby and French 1985) reinforce this interpretation. Alesch and Petak (1986), for example, argue that the City of Los Angeles did not adopt a structural retrofit ordinance after a series of major earthquake events over a 50-year period, because local officials did not have a readily available solution that was both technically feasible and politically acceptable to various interest groups. Thus, at least these data, past experience contributes little to influencing local response.

CONCLUSIONS

Three general questions were addressed: 1) To what extent have various planning measures been adopted for earthquake hazard mitigation? 2) What is the relative importance of process activities compared to context characteristics? and 3) To what degree do factors that influence adoption differ between communities in California and in those of all other states?

Survey results indicate that communities adopted a wide variety of planning measures for earthquake mitigation. The most frequently used measures for both California communities and communities in all other states are typically enacted for nonhazard reasons, but to some extent can be used for earthquake mitigation. These measures include building codes, comprehensive plans and zoning, and subdivision ordinances. Other measures that specifically address earthquake mitigation are used more frequently in California. However, caution should be exercised in interpreting survey findings on California's relatively more extensive experience. While adoption of planning measures for earthquake mitigation is more frequent than the rest of the nation, it is substantially less frequent compared to other types of natural hazards.

A second question of this study concerned the relative effects of process factors, or those activities that planners and other decision makers can use to advance planning programs, and community context characteristics. Overall study findings indicated that planning process factors had an important influence on local efforts to adopt planning measures for earthquake mitigation. In contrast, community context characteristics played a less important explanatory role. Thus, efforts to advance local earthquake mitigation activities through enhancement of planning process actions have a relatively substantial potential for success.

This finding is significant, particularly in regards to several studies in planning and organizational decision making. These studies contend that environments dictate organizational actions and that planners and decision makers can do little to affect organizational responses. That is, decision makers are rigidly constrained by their contexts (Aldrich 1979 and McKelvey 1982). Our research indicates that at least for our survey data of community planning organizations this was not the case. Decision makers can have a strong positive influence on responses.

The final question addressed differences in causes of community adoption of planning measures between California communities and those in other states. There were two main differences. First, the presence of advocates was a more important cause of adoption in communities outside of California. Second, integration of seismic program formulation activities with more conventional comprehensive planning activities was more important among communities outside of California.

This research is a preliminary effort at conceptualizing and testing connections between community mitigation responses to earthquake hazards, and planning process and community context factors. Although this research has implications for practice, as discussed above, there is a need for longitudinal studies that identify those process activities that would be most effective under different phases of work over a problem solving sequence (e.g., initiation of agreement, search for solutions, adoption, implementation, and evaluation). Van de Ven's work (1980a, 1980b) exemplifies this type of research. In addition to measuring process factors in a similar way to this study's measures, Van de Ven was able to specify which activities are most effective during different phases. Van de Ven was also able to demonstrate the superiority of a specific sequence of phases (the Program Planning Model) over a more random, unstructured process. Hence, only longitudinal studies can reveal which sequences are most effective under different contexts, and which process activities work best for various phases.

Table A-1

LIST OF VARIABLES AND MEASUREMENT

VARIABLE	MEASUREMENT
DEPENDENT	
Innovative Mitigation Measures	Respondents were asked to indicate whether each of 21 local land use and development mitigation measures were adopted by their community. Responses were coded 0=no and 1=yes and summed. Only those measures that specifically addressed seismic hazards and were not adopted in response to state legislative mandates were used.
INDEPENDENT	
Program Operations	
Advocates Influencing Planning Decisions	Respondents were asked if any individuals or groups advocated concern for earthquake hazards in their jurisdiction. Responses were coded 0=no and 1=yes.
Hazards Integrated into Comprehensive Plan	Respondents were asked if earthquake mitigation program formulation activities are integrated into comprehensive planning activities of their jurisdiction. Responses were coded 0=no and 1=yes.
Number of Concerns Linked to Earthquake Hazards	Respondents were asked to indicate which concerns were linked to earthquake hazards in their jurisdiction from a list of seven concerns. Responses were coded 0=no and 1=yes and summed.
Media Attention	Respondents were asked if there is a media campaign in their communities to make the public more aware of earthquake hazards in their jurisdiction. Responses were coded 0=no and 1=yes.
Program Support	
Staff Hours	Respondents were asked approximately how many hours per week were devoted to earthquake problems by their staff. Responses were coded 1=less than one person-hour, 2=1 to 7 person-hours, 3=8 to 39 person-hours 4=40 person-hours or more.
Percentage of Planning Department Budget	Respondents were asked approximately what percentage of the departments annual operating budget is allocated to earthquake problems. Responses were coded 1=less than 1 percent, 2=1 to 5 percent, 3=6 to 20 percent, 4=greater than 20 percent.
Change in Budget	Respondents were asked to compare the budget percentage allocated to earthquake problems to the budget percentage 5 years ago. Responses were coded 1=much less, 2=less, 3=about the same, 4=greater, 5=much greater.
Lack of State or Federal Financial Support	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.
Inadequate Staff Expertise	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.
Inadequate Maps Delineating Earthquake Hazards	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.
Interorganizational Relations	
Number of Inter-organizational Contacts	Respondents were asked to indicate the average number of times they were contacted face to face, telephone, meetings, letters, reports, etc.) in the last year for eight federal, state and local agencies and groups. Responses were coded 0=no contact and 1=1 or more contacts and summed.
Organizational Responsiveness	Respondents were asked to rate on a 5 pt. Likert Scale (1=not responsive to 5=very responsive) the responsiveness of eight federal, state and local agencies and groups to needs and problems related to earthquake hazards in their jurisdiction. Responses of 1,2 and 3 on the scale were coded as 0= not responsive, and 4 and 5 were coded 1= responsive. The coded responses were then summed.
Community Context	
Median Home Value	Census data was recorded to identify the median home value for each respondents jurisdiction in 1980.
Population Size	Census data was recorded to identify the population size of each respondent jurisdiction for 1980 with 10,000 as the lower limit.
Past Experience	Respondents were asked to indicate when the effects of an earthquake were last experienced in their jurisdiction. Responses were coded 0=more than 30 years ago and 1=30 years ago or less.
Number of Seismic Related Hazards	Respondents were asked to indicate which hazards are in their jurisdiction from a list nine seismic related hazards. Responses were coded 0=no and 1=yes.
Perceived Risk	Respondents were asked to rate on two separate 5pt. Likert Scales: 1) the chances that a major earthquake will occur in your jurisdiction over the next 30 years 2) the ability of structures in your jurisdiction to withstand a major earthquake. Responses were coded 1=very low chance to 5=very high chance and 1=very low ability to 5=very high ability, respectively, and added to form a new variable. (Cronbach's Alpha=.654)
Conservative Attitude Toward Government Control of Private Property	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.
Legal Restraints in State Law for Planning and Managing Development	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.
Lack of Public Interest about Earthquakes	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.
Opposition of Real Estate or Development Interests	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.
Lack of Support by Local Elected Officials	Respondents were asked to rate on a 5 pt. Likert Scale the seriousness of this obstacle in reducing earthquake activities in their jurisdiction. Responses were coded 1=very serious to 5=not serious.

NOTES

1. Because our primary objective was to determine why some communities are doing more to mitigate earthquake hazards than others, the dependent variable consisted only of the number of locally adopted planning measures that were specifically enacted to mitigate earthquake hazards (as indicated by the survey questionnaire) and that are not required for adoption by state mandates. Of the 21 measures listed on Table 2, five (building codes, zoning and subdivision ordinances, comprehensive plans, and capital improvement programs) can be used to some extent for earthquake mitigation, but are typically enacted for non-hazard reasons. To identify which of the measures are required for adoption in California we referred to a report by the California Seismic Safety Commission (1986). Similarly, we referred to the directory of state building codes (NCSBCS 1988) to identify those states outside of California that have mandated local adoption of other types of measures.
2. In fact, we expected a much greater proportion of localities in California to indicate adoption of these measures. For example, all localities in California are required by law to have adopted an earthquake component of comprehensive plans, yet as shown in Table 2 not all respondents indicated this measure was in use. This can perhaps be explained in several ways. First, some respondents may simply be unaware that mitigation measures exist. Another explanation is that respondents interpreted the question as asking whether these measures were being used to mitigate earthquake risks. While a locality's comprehensive plan may contain a seismic element, the element may be seldom, if ever, implemented. The respondent, then may recognize the existence of the provision on paper, but see no clear application or use of this provision (and thus failing to circle the measure). Finally, the existence of a state mandate or requirement certainly does not ensure that localities will adopt these measures. It is entirely possible that some localities have ignored the state mandates.
3. The dependent variable, the number of adopted planning measures, has been used in numerous studies (cf. Burby and French 1980, 1981, and 1985; Godschalk et al. 1982; Hansen and Hirsch 1983). Indeed its acceptance as a measure is one important reason we chose to examine it. However, as discussed in endnote #2 our study seems to have uncovered some flaws with the measure. Problems with the measure are obvious, but no clear substitute exists. Our use of the measure should enable clear comparisons between our study, and others. Further, it would seem that the same measurement problems should be present in California and other states. So, while we should be cautious about statements concerning the degree of acceptances, conclusions about relative differences among states and relations between independent and dependent variables are less problematic.
4. An important limitation of the staff hours variable should be noted. The survey did not differentiate between staff time devoted to formulation and enactment of seismic mitigation measures, and implementation of such measures. Consequently, staff time may not be an accurate indicator of local adoption.
5. Seismic zone classification (see Figure 1) was orignially considered as an independent variable. However, the variable was not used in the regression analysis due to lack of variation. Eighty-one of the 82 communities surveyed in California are in seismic zone four, and two of the 120 communities in other states are in seismic zone four.

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